Lec: 9

Liners and bases:
Materials placed between dentin and the restoration to provide pulpal protection. Protective needs for a restoration vary depending upon:
1) The extent and location of the preparation.
2) The restoration material to be used.

The characteristics of the liner or base selected are largely determined by the purposes that it is expected to serve.

Sealers:
Materials provide a protective coating to the walls of the prepared cavity & a barrier to leakage at the interface of the restorative material and the walls.

Liners:
Are relatively thin layers (< 0.5 mm) of material used primarily to achieve a physical barrier to bacteria and their products and /or to provide a therapeutically effect, such as anti bacterial or pulpal sedative effect. Liners are usually applied only to dentin cavity walls that are near the pulp.

Bases (cement bases 1-2 mm):
Are used to provide thermal protection for the pulp and to supplement mechanical support for the restoration by distributing local stresses from the restoration across the underlying dentin surface. This mechanical support provides resistance against disruption of thin dentin over the pulp during amalgam condensation procedures or cementation procedures. Some base materials are irritating to the pulp before the setting reaction has completed, such a base may be used in conjunction with a liner.
The properties of an ideal lining material:
1) It should be easy to supply.
2) The strength should be enough to withstand the condensation forces.
3) It should not irritate the pulp or interfere with the setting reaction of the restoration.
4) Radioopaque.
5) It should have a bacteriostatic effect.
6) Well adapted to the cavity walls.
7) Reduce thermal conductivity of the restoration.
8) It should prevent chemical exchange between the restoration and the tooth.

Varnish sealer:
It is a natural gum (copal resin) or a synthetic resin dissolved in a solvent such as chloroform, alcohol, acetone. The solvents evaporate leaving the resin behind.

Uses:
1) Varnish is frequently used under amalgam restoration because it reduces significantly the leakage around the margins and walls of the restoration. Varnishes have been used for many years to fill the gap at the amalgam-tooth interface until corrosion produce products form to reduce it.
2) Used as barrier against the passage of irritants from cements or other restorative materials and to reduce the sensitivity of freshly cut dentin. It is not thick enough to provide thermal insulation. Not used with composite materials, as they would interfere with adhesion.

Manipulation:
Usually applied by means of a small round piece of cotton according to the size of the cavity, we paint the entire cavity preparation. A minimum of 2 thin films should be applied, as the initial layer dries it leaves small pinholes and the second coating fills in the voids and produces a more continuous coating.
Calcium hydroxide:
Has long been used as a base liner under restorative material. Ca(OH)$_2$ is supplied either as a suspension type or as a paste system, one paste contains calcium hydroxide(catalyst) while the other contains salicylate(base).

Uses:
1) They are recommended materials for direct pulp capping.
2) As base/ or liner under other dental restorative materials. They are still recommended when a cavity preparation leaves little dentin covering the pulp or when a micro pulp exposure is suspected.

Properties:
1) It has ability to stimulate reparative dentin formation with direct pulpal contact.
2) Serve as a protective barrier between tooth tissues and acid containing cements and restorative materials since it has high PH.
3) Has antibacterial action that reduces the inflammatory effects of bacteria on the pulp.
4) Conventional calcium hydroxide liners have demonstrated poor physical properties (high solubility, have low values of tensile and compression strength). Visible light- activated calcium hydroxide over come most of these deficiencies.

Manipulation:
Equal lengths of the different colored pastes are dispensed on a paper pad and then mixed to a uniform color with ball-point instrument; the setting time is 2-3 min. mixing time 10 sec. at room temperature.
The setting reaction of Ca(OH)$_2$ is accelerated by water, the moisture present in dentin is sufficient to cause the material to set within seconds of application on the dentin surface.

Zinc-phosphate cement (ZPC):
Has been used in dentistry for centuries, and still quite popular. ZPC is supplied as a powder and liquid.
Powder: consist of zinc oxide chiefly with additions of magnesium oxide and silicon dioxide, and other minor ingredients.
Liquid: consists of a water solution of phosphoric acid.

**Properties:**
1) Strong and has a low solubility compared to other cements.
2) Because the mixed cement has a low pH until it has set, ZPC is irritating to the pulp.
3) ZPC sets to a hard brittle material. It can withstand amalgam condensation forces and support the overlying amalgam restoration.

**Uses:**
1- For luting inlays, crowns, bridges, orthodontic bands. ZPC has a long working time compared to other luting cements [1-1.5 min].
2- Used as a base material. It is acidic and the pulp may need to be protected with a liner or a varnish. Also ZPC indicated for replacement of lost dentin.

**Mixing:**
1) ZPC is dispensed as scoops of powder and drops of liquid, the No. of drops and scoops of powder required are found in the directions provided by the manufacturer. A cement spatula and glass slab is used. The reaction is very exothermic, the heat of the reaction accelerates the setting rate so it is important to dissipate this heat by:
   - A large portion of a cooled mixing slab must be used during mixing (cooling obtained by placing the slab under cool water or in a refrigerator).
   - The powder must be added in small increments.
   - The mixing time must extend to 1.5 to 2 minutes.
2) The powder is dispensed on the middle area of the slab and divided into small equal parts; the liquid is dispensed with an eyedropper on the other area of the slab. The mixing is started by adding the 1st small increment of the powder into the liquid and continuously spatulated, then the 2nd part of the powder incorporated and so on. A primary consistency is usually attended at the end of 1.5 min.
Advantages of incorporating small increments of powder over a large area of the slab are: dissipating the heat of reaction, permit a greater quality of powder and smoother mix as well as longer working time and less acidity.

3) ZPC is mixed to the proper consistency depending on the clinical use. The mix is thinner (lower P/L ratio) when used for luting, and thicker consistency (higher P/L ratio) used as a base.

4) Insertion: a small quantity of cement is picked up on the point of a right-angled probe (lightly rolled into a ball with fingers) and placed on the floor of the cavity. Then it's tapped with an instrument, covered with powder of cement to prevent the cement from sticking to the instrument. The cement then shaped with instrument such as Ash. For class II the cement is pressed against the axial wall, pulpal floor and the axiopulpal line angle. Any trimming with bur should be delayed until complete setting of the cement to avoid dislodgment and should be carried out with sharp bur and low speed and minimum pressure. The same technique applied to class V cavities.

**General notes:**

- It is important not to dispense the liquid until one is ready to mix the cement, because high or low humidity will affect the water content and therefore, affect the reactivity and the properties of the resulting cement.
- ZPC powder comes in shades. The color of any cement can affect the esthetic of translucent restorative material.
- On patient mouth the cavity should be completely dry, otherwise the cement will not adhere, and brittle cement is produced.
- Very fine excavator may be used to remove cement which has obliterated the under grooves.
- Characteristic of a proper mix: for luting agent the mix should be stretched 1 inch between the slab and spatula. As a base material, it should be thicker, putty-like and it can be rolled into a ball with fingers coverd
with cement powder. A proper base mix will not stick to instruments and can be pushed or condensed into place.

\[
\text{Exothermic} \\
2 \text{ZnO} + 4 \text{H}_2\text{PO}_4 \quad \text{reaction} \quad 2 \text{ZnHPO}_4\cdot3\text{H}_2\text{O} + \text{heat}
\]

**Zinc oxide eugenol (ZOE):**

There are 2 types:

1) **Unreinforced ZOE (ordinary type):** supplied as powder (zinc oxide + some additives like zinc acetate, white resin to increase strength of the material). Liquid: eugenol. Such ZOE formulations for temporary cements are popular and perform adequately.

2) **Reinforced ZOE products** are stronger and less soluble than the first one. Additives include either alumina, or polymethyl methacrylate resin is added to the powder. And the liquid contains in addition to eugenol ethoxybenzoic acid (EBA) used as intermediate bases.

**Properties:**

1- ZOE has a sedative effect on dental pulp, and it is for this reason that it is used as temporary restoration before a permanent one is used.

2- Radioopaque.

3- It adapts very closely to dentin, thus providing a good marginal seal.

4- Its antibacterial properties inhibit bacterial growth on the cavity walls.

5- Eugenol inhibits free radical polymerization of composite materials, so ZOE is contra-indicated under composite.

6- Neutral in PH so, can be safely used in moderately deep cavities.

**Uses:**

1) As temporary restoration (ordinary type).
2) To create an insulating base under permanent restorations (modified type).
3) To cement a temporary crown.

Mixing:
The powder is measured and dispensed with a scoop. The liquid is dispensed as drops. A glass slab is used for mixing P/L ZOE products. The powder is forced into the liquid using a cement spatula. The mixing process first incorporates large increments of powder then smaller increments. Spatulate the powder and liquid in quick motion with the flat side of the spatula, using a small portion of the mixing surface. Continue the procedure until the mix become thick, putty-like and it can be rolled into a ball with fingers without sticking to the skin for temporary restoration or as a cement base. For cementation we use the same way just with a different consistency (creamy).

Insertion:
As a temporary restoration carried with any suitable flat-bladed instrument to the cavity, packing is best affected by the use of a ball shaped piece of cotton damped with water or a plastic instrument may be used after dipping them in dry ZOE powder. The patient is requested to close his mouth, bringing his teeth together in occlusion function, the proximal and cervical areas are contoured as carefully as if this was a permanent restoration.
As a base inserted in the same manner described for ZPC. Mastication on ZOE dressing should be limited. M.T 1 1/2 min.

Polycarboxylate cement:-
Was the first adhesive material developed for use in dentistry supplied as:
1) Powder + liquid: powder is zinc oxide and magnesium oxide. (Stainless steel fibers + alumina to increase the strength). Liquid is a weak solution of polyacrylic acid (30-50%) which is very viscous.
2) Water hardening cements or water setting:
P: zinc oxide or glass powder is mixed with the powdered anhydrous, freeze, dried, polyacrylic acid.
L: water.

Properties:
1- Polycarboxylate cement is not as acidic as ZPC because of
   i) The PH of polycarboxylate rises more rapidly than that of ZPC.
   ii) The large size of the polyacrylic acid molecules compared with phosphoric acid may limit its diffusion through the dental tubules and is very biocompatible.
2- The carboxylate groups of polyacrylic acid bond to calcium in tooth structure, and the bond to the enamel is stronger than dentin.
3- Polycarboxylate cement adheres to gold casting alloy.

Uses:
1) Intermediate base.
2) Luting cements
3) Used for direct bonding of orthodontic brackets to teeth.

Mixing:
The powder and liquid are dispensed and mixed on a paper pad with a cement spatula. The liquid should not be dispensed until one is ready to mix, as water can evaporate and cause increase in viscosity with decrease in strength and higher solubility. The powder is rapidly incorporated to the liquid in large quantities; we should complete mixing within 30 -45sec. in order to provide sufficient working time (2.5 - 6 min.).

The mixed material must be placed while the cement is still glossy which indicate that the liquid still available to bond to the tooth "adhesion depends on unreacted carboxylic acid groups".

For placing the material as a base the procedure is similar to that of ZPC.
**Glass ionomer cement (GIC):**

Powder: is an acid soluble, calcium fluoro-alumino silicate glass.
Liquid: an aqueous solution of polyacrylic acid that contain carboxyl group (viscous liquid). Uses

1- As a base material in deep cavity
2- As a luting agent for permanently cement crown and orthodontic band and may
3- As a restorative material.

**Properties:**
- GIC materials are strongest and least soluble dental cements. They are also adhesive and release fluorides. They have a good biocompatibility.
- GIC materials bond to tooth structure; in addition they bond to stainless steel and alloys ceramometal crown.
  - Dehydration causes crazing and cracking and produces an opaque restoration. Water absorption can cause swelling and surface disruption and protection is required for 10-30 min. after placement.

Various improvements in the original material have been made and incorporated into a number of formulations:

1- Conventional GIC: this is composed of powder, which is Ca, fluoro alumino-silicate glass, and the liquid is polyacrylic acid. Used as liner, base, cement.

2- Metal- modified glass ionomers: (used as filling material for class V (permanent teeth), class I and II (primary teeth), bases under composite and amalgam, cores).
  i- Miracle mixture (amalgam alloy particle admixed with cement powder).
  ii- Cermet particle reinforcement (Ag-Pd). Much stronger than unmodified, but had poor esthetic.

3- Light cured glass ionomers: (liners, bases) hydroxyethyl methacrylate (HEMA) added to liquid component and light cure
accelerator. Other powder particles mixed with aluminosilicate glass. Is more desirable under composite materials because this type is acid resistance.

4-Hybrid (resin-modified) glass ionomers (cements, restorative filling material, cores).

- HEMA and other polymers added to the liquid component.
- Polymers added to powder component.
- Silicate glass of composites substituted for some powder.

They are light cured, less technique sensitive, stronger.

**Mixing:-**

It's critical that GIC is properly mixed and handled. If it is not, non-adhesive materials result. The powder is dispensed with a scoop, and the liquid is dispensed as drops. A cement spatula and paper pad are typically used "special mixing pad will keep all the liquid available for the reaction and facilitate spatulation". The powder incorporated into the liquid in one or two portions and the mixing process is much quicker than for ZOE, ZPC, if the mixing procedure is too slow, the resulting mix becomes too thick. Mixing time 30-45 sec. S.T. 7 min. W.T. 2 min.

The best results have been obtained when the material is applied to clean cavity walls that are well isolated in a dry field. The mixed cement should be used only as long as it still appears glossy on the surface.

GIC may be dispensed in disposable capsules that mixed in an amalgamator. Specific directions for mixing are provided by the manufacturer. The capsule has a "spout" where the mixed material is expressed from the capsule with a gun or dispenser.

The use of GIC as intermediate layer between dentin and resin composite is often referred to as (sandwich technique).

GIC use most often in conjunction with class II resin composite restorations is sometimes called the bonded-base techniques.
• In shallow cavity (1-2 or more of remaining dentin) for amalgam restoration: the cavity is coated with 2 thin coats of a varnish and restored. For composite restoration, the cavity is etched, primed coated with single coat of a bonding agent and then restored.

• Moderately deep cavity, varnish is used first then cement base such as ZPC or modified ZOE cement may be contoured to replace the missing dentin, then amalgam restoration.

• If we want to use adhesive base cement (GIC, polycarboxylate cement) varnish or bonding agent is not indicated at first because the coating will eliminate the potential for adhesion.

• In deep cavity:
  - a liner such as Ca (OH)2 on the pulpal and axial wall, over laid with a base
  - Then restorative materials.

If there is a pulp exposure, calcium hydroxide is used to stimulate reparative dentin.

The best possible base for any restoration is sound tooth structure. So you must remember that:
Don’t remove sound tooth structure to provide space for a base. Maintaining sound dentin will enhance restoration support and provide maximum dentin thickness for pulpal protection.

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